Deformation

Grades	2-6	
Duration	40min	
Setting	Classroom	

TEKS

Science – Ch112

K.3	K.4	K.5	K.7	K.10	1.3	1.4	1.5	1.7	1.10	2.3	2.4
2.5	2.7	2.10	3.3	3.4	3.5	3.7	3.8	3.11	4.3	4.4	4.5
4.7	4.11	5.3	5.4	5.5	5.7	5.12					

Focus Demonstrate material responses to stress.

➲ *Read side 2 for* Background.

Objective The student's task is to apply varying stresses on selected materials.

Procedure

1. Explain the idea of deformation. Ask the class to speculate on some of the ways that every day objects and materials respond to different types of physical stresses.
   - *Why do some materials accept more stress than others?*
   - *What qualities enable solid objects to withstand different physical stresses? [Give examples, hammer & nail, car bumpers, sports balls etc.]*

2. Holding it up for the class to see, stretch and release a rubber band. Explain that as its being stretched the rubber band is storing the energy.
   - *How does the rubber band deform under this stress?*
   - *What is the quality that enables the rubber band to withstand stretching?*

3. Stretch some silly putty for the class to see. It shapes and contorts without ever breaking. Because the silly putty hasn't broken into separate pieces it is considered *ductile.*

4. Leave your large blob of silly putty prominently on a table for the class to see. Distribute the room temperature silly putty to the class. Ask them to demonstrate ductile deformation with it.

5. Distribute the cold silly putty and have the students try to deform it. *[If its very cold, it will break.]*

6. Encourage students to continue deforming the putty, making observations of its behavior as it slowly warms up. Once warm, have the students pull quickly on the putty.
   - *What happens?*

7. Distribute the tootsie rolls and have the students deform the candy in their mouths.
   - *What happens as it warms up?*

Materials

rubber band
frozen silly putty
room temperature sully putty
tootsie rolls

Did You Know?

Mostly we think of rocks as rigid, but a type of rock called itacolumite, found in parts of India and North Carolina, is easy to bend with your hands.

➲ *Read side 2 for* Background.

Deformation

Background

In geology, we talk about the **deformation** of materials, by which we mean the response of the material to being stretched, bent, squeezed or otherwise stressed. Rubber bands demonstrate *elasticity* in response to the stress of being stretched. In its stretched position the rubber band is storing energy. Saltwater taffy demonstrates *plasticity* in response to the stress of being pulled or stretched. When a material is stressed past its strength limit and breaks into separate pieces, as with the pencil, then the deformation is brittle.

Most materials are not inherently *brittle* or *ductile*. The material response depends upon conditions of deformation—the temperature, pressure and the rate at which the stress is applied. Under the great pressures and temperatures found within the Earth, rocks may bend and even flow, while the same rock—exposed on the Earth's surface—would be brittle and break.

We consider the Earth's crust a series of plates composed of different elements and rock materials. The composition and stresses that the individual plates are exposed to determine some of the formations that we see in our landscape. Moreover, the response of the Earth's crust to the stresses imposed by the planet's deeper layers, results in geologic activity all over the globe.

Plates on the Move

Most geologists think that powerful convection currents in the mantle driven by heat from the Earth's core and radioactive decay, are the force behind many of the changes that occur in the crust.

In the 1960's geologists developed an exciting new theory called **plate tectonics**. The theory proposes that the *lithosphere* (the crust and the uppermost layer of the mantle) is not a continuous sheet of solid rock. Instead it is divided into about 12 enormous plates and many smaller plates that "float" like icebergs on the top of the *asthenosphere*. These plates, which can be hundreds of thousands of miles across, move relative to one another and they carry the continents and ocean basins with them as the drift about. For example, most of North America and a good part of the Atlantic Ocean are on the North American Plate. But Hawaii, part of California and Alaska, and most of the Pacific Ocean are part of the Pacific Plate.

Slippin' and Slidin': Plate tectonics revolutionized geology because it finally explained how major geological events occur. Geologists could see that most mountain building and earthquake and volcanic activity take place along the margins of the plates. And as they studied the ways plates interact with each other, they found that in some areas new crust is always forming, while in other areas old crust is constantly being destroyed. Here's a look at the main ways the plates interact with each other to influence the crust:

- ***Oozing Crust***—New oceanic crust is formed at ocean rifts, where two plates pull apart from each other. Magma (hot, molten rock from deep in the Earth) oozes out from cracks along these rifts and hardens to form new crust. (When magma reaches the surface of the Earth, it is called **lava**.) **Sea-floor spreading** is the result of this oozing lava at the bottom of the oceans.
- ***Crash***—Just as some plates are moving away from each other, other are moving toward each other. When two plates carrying continents run into each other, the collision usually crumples the leading edge of both plates and creates lofty mountain ranges over a period of millions of years. For example, the Himalayas were formed when the plate carrying India collided with the plate carrying Eurasia.
- ***Bye, Bye, Plate***—Old plates never die, they just **subduct**. If two plates collide and one is made up of continental crust and the other is made up of oceanic crust, a deep trench forms in the ocean floor as the denser oceanic plate bends down and slides under, or subducts beneath, the edge of the other plate.
- ***Just Scraping By***—Sometime two plates slide sideways past each other, as the Pacific and North American Plates are doing along California's San Andreas Fault. (A **fault** is a break in the Earth's crust caused by stress that are usually related to plate movement.) The slipping motion usually causes earthquakes, but neither plate is destroyed in the sideways movement.
- ***Underwater Torches***—In some places, a narrow plume of hot material rises up through the mantle and creates a hotspot under the plate. The extra heat melts some of the mantle rock, which makes its way up through the plate to form a volcano. As the plate slowly moves over the stationary hotspot, a line of volcanoes is formed. (Once a volcano drifts beyond a hotspot it becomes inactive. But a new, active volcano will form over the hotspot.) Some geologists think that a hotspot under the Pacific Ocean created the Hawaii Islands.

Did You Know?

The Hawaiian volcano, Mauna Kea, is the wolrd's tallest. From its base on the ocean floor to its summit, it's over 33000 feet tall—more than 4400 feet higher than Mt. Everest!

Bibliography & Sources

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